Battle Won, War Lost

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Introduction

Osteomyelitis is the term that refers to inflammation and infection of the medullary cavity, cortex, and periosteum of bone, most commonly seen following bacterial infection of a compound fracture (2,9). The most frequently associated aerobic bacteria are *Staphylococcus spp.*, *Streptococcus spp.*, *Escherichia coli*, *Proteus spp.*, *Pasteurella spp.*, *Pseudomonas spp.* and *Brucella spp.* However, anaerobic bacteria are less frequently isolated and may be part of a polymicrobial infection. Depending on the geographic distribution, fungal diseases can also cause osteomyelitis such as *Coccidiodes immitis* (southwestern USA), *Blastomyces dermatidis* (southeastern USA), *Histoplasma capsulatum* (central USA), *Cryptococcus neoformans*, and *Aspergillus spp.* (worldwide) (9,10). Factors that contribute to infection include: ischemia, trauma, focal inflammation, bone necrosis, and hematogenous spread (11).

History and Presentation

Clinical signs vary with the length and severity of infection and the organism involved. Clinical signs may be acute or chronic (11). Animals with acute osteomyelitis usually exhibit localized inflammation and soft tissue swelling. The animal may exhibit lameness, pain, abscessation at the wound site, fever, anorexia, and depression. Acute bacterial osteomyelitis is seen most often in very young animals and is usually of hematogenous origin. It is often secondary to respiratory, gastrointestinal, or umbilical infections (10). In adults, acute form of osteomyelitis is rare and is usually associated

with direct bacterial inoculation from a traumatic event. Osteomyelitis is often associated with septic arthritis and may involve infection of the epiphyseal, physeal, and metaphyseal regions of the long bones (10).

In general, osteomyelitis is a chronic disease characterized initially by inflammation of the affected area (11). Animals with chronic osteomyelitis often do not show signs of fever or depression (10). In adults, infection is usually localized and is the result of direct trauma to the bone. Common signs of chronic osteomyelitis include: firm swelling of the affected area, reluctance to bear weight on the limb, mild to moderate lameness, and presence of draining tracts (10, 11). These inflammatory areas may form fistulas that drain and appear to heal only to break open and drain again. This cycle often repeats itself if not properly treated.

Other clinical signs seen with osteomyelitis depend upon the area of infection. Infection affecting long bones and joints of the legs is accompanied by painful swellings and lameness (7). Systemic reactions from these infections may not be observed. Young animals suffering joint infections secondary to septicemia will often display fever, depression, and recumbency (8). If fractures are present, healing is often delayed resulting in a non-union. (7).

Pathophysiology

Osteomyelitis is an infection/inflammation of the bone. The initial infection leads to the recruitment of inflammatory cells, predominately polymorphonuclear neutrophils (75-90%) and T-lymphocytes (5-15%) (13). Cells rarely seen included B-lymphocytes, monocytes, and stem cells (13). Polymorphonuclear neutrophils and T-lymphocytes release lysosomal enzymes that induce bone and tissue necrosis (2,13). If left untreated

the infection will progress to the point where it affects new bone formation and can reach a chronic state. Osteomyelitis can be caused by several different factors.

Traumatic Osteomyelitis

One of the most common causes of osteomyelitis is trauma resulting in damage of the bone and introduction of foreign bodies which can cause particular species of bacteria to come in contact with the bone (2). This is typically referred to as post-traumatic osteomyelitis. Neonates often develop osteomyelitis following failure of passive transfer and subsequent septicemia, but they also have a higher frequency of long bone fractures which are easily infected if skin is compromised and the fracture is open (11). The severity of osteomyelitis depends on the characteristics and potency of the pathogen that is causing the infection, the properties of the host, and the location in which it occurs (7). After the bone is infected, there are three possible outcomes: the bone can heal, it can be a calm and long lasting infection, or it can become a chronic infection that will progress to deterioration of the bone (2). Most often when the infection develops, it cannot be healed by the host's immune system or even antibiotic therapy. To completely heal the infection, surgical debridement is essential (4).

Hematogenous Osteomyelitis

Hematogenous osteomyelitis occurs when bacteria are spread via the bloodstream into the bone (2,9). The typical sites of infection resulting from hematogenous spread are joints and the ends of long bones due to their vascular arrangement, which is predisposes them to bacterial colonization (11). This type of infection can be classified as primary or secondary. Primary hematogenous osteomyelitis happens when the bacteria in the blood directly invade the bone (2). This is more common in younger animals. Secondary

hematogenous osteomyelitis is when the infection is caused by a distal site (2). This is more commonly seen in adult animals. When chronic hematogenous osteomyelitis is present, the cortex is healthy. The most common bacteria associated with hematogenous osteomyelitis is *Pasteurella spp*. and *Salmonella spp.* (11).

Contiguous-Focus Osteomyelitis

Contiguous-focus is when the infection forms from an adjacent soft tissue that is infected (9). However, contiguous-focus can also occur through a small infection that directly contacts the bone at the time of trauma, or even spread by contamination in a preoperative or intraoperative procedure (2). When osteomyelitis occurs this way, the infection will often lead to persistent bone infection and require removal of infected sections of the bone.

Diagnostic Approach

Osteomyelitis is often diagnosed by careful examination of the infected area followed by diagnostic imaging. There are many imaging methods that will allow evaluation of the affected area. Radiography is often used, although it can take up to 2 weeks after infection to visualize bone destruction and remodeling (2). Early signs of osteomyelitis seen radiographically are enlargement of the periosteum and swelling of the soft tissue. Radiography can also reveal bone lysis, sequestration, irregular periosteal reaction, loosening of implants, and fistulous tracts (3). Ultrasound can be used but will only allow visualization of the soft tissue and surface of the bone; therefore, it is not the most effective way to visualize and detect osteomyelitis (2). Computed tomography (CT) scans offer a high levels of detail in cases of osteomyelitis. The main drawbacks of using CT are the expense and cases with metal implants. Metal implants created scatter

affecting the image quality (9). Radionuclide imaging can be used to identify more subtle areas of bone inflammation and can be particularly useful when bone implants are involved (2,9). One technique utilizes methylene diphosphonate scintigraphy which concentrates at areas with increased blood flow and bone remodeling. Another technique involves isolation of the patient's leukocytes which are then labeled and injected back into the patient (2). These methods are not currently used in food animals however, because no meat or milk withdrawal periods are established, and they are not cost effective (9). The above methods are suggestive of osteomyelitis, but to receive a definitive diagnosis of osteomyelitis bone biopsy and a bone culture must be performed (9).

Treatment/Management

Treatment of osteomyelitis is often challenging, and an extended period of time may be required for complete healing. Principles of osteomyelitis treatment include: control existing infection with appropriate levels of antibiotics that are effective against the causative organism, perform debridement(s), surgically remove infected bone or necrotic material, and prevent reinfection of the bone or joints originally involved (7,8,9 11).

Acute osteomyelitis is more likely to respond to aggressive antibiotic therapy (2). Initially, the choice of appropriate antibiotic is based on known susceptibilities of the organism suspected to be responsible for infection. Culture and susceptibility should be used to identify the infective agents, and therapy should be adjusted according to susceptibility patterns (11). Parenteral administration of antibiotics constitutes the mainstay of antimicrobial therapy in the treatment of osteomyelitis. Localized antibiotic

therapy provide a useful adjunct to systemic antibiotic treatment. Regional limb antibiotic perfusion, local implantation of polymethylmethacrylate antibiotic-impregnated beads, and use of autogenous cancellous bone grafts enhance the resolution of osteomyelitis (5,10). Care must be exercised in observing milk and slaughter withdrawal times when administering antibiotics to food-producing animals. It may be necessary to continue antibiotic therapy for extended periods of time with a minimum of 3 weeks to control existing bone infections (9,11). Once infection is established in bone, it is difficult to resolve without surgical intervention (5).

Broad-spectrum antimicrobial administration in combination with surgical management constitutes the hallmark of treatment for osteomyelitis (10). Surgical removal of a sequestrum or foreign body is necessary in the management of osteomyelitis. Curettage is employed to remove nonviable bone and necrotic tissue. Curettage facilitates the penetration of blood-borne antibiotics to the site of infection by eliminating necrotic debris and encouraging vascular access to compromised tissues (11). Severe joint infections with bone involvement are treated by joint lavage and intraarticular antibiotic (7). Arthrotomies and drains may be placed surgically in joints to facilitate lavage and drainage over a period of days. Depending on the joints involved infections can be difficult to treat and unrewarding when the damage is severe resulting in chronic osteoarthritis (6).

The immunoglobulin status of neonates should be evaluated in all cases. If a deficiency is found, plasma should be administered (11).

Prevention

Prevention is the best mode of treatment for osteomyelitis. Several ways to prevent osteomyelitis would be: to ensure adequate colostrum ingestion, proper environmental hygiene, dipping of calves' navel after birth, and strict monitoring of neonatal disease, all would minimize the chance of developing osteomyelitis (12). Early vigorous treatment of all open fractures and wounds where bones are exposed is necessary to prevent osteomyelitis (11). Any wound that potentially involves bone should be completely debrided, and the animal should be placed on appropriate antibiotics (9).

Outcome/Prognosis

The prognosis of osteomyelitis is dependent on the severity, duration, and aggressiveness of therapy. The immune status of the animal plays a very important role in the outcome of bacterial invasion (11). Localized cases treated early and aggressively with appropriate therapy should respond well. When cases go undiagnosed or unrecognized for days before therapy is instituted, a poor prognosis is expected (10).

Conclusion

In conclusion, osteomyelitis is a preventable infection of the bone (11). Osteomyelitis is either transmitted via hematogenous spread or traumatic injury to the bone (2). Detection is critical and most likely found by radiography where enlargement of the periosteum, swelling of the soft tissue, bone lysis, sequestration, irregular periosteal reaction, and fistulous tracts may be observed (2). It is best to prevent osteomyelitis, but in cases where treatment is necessary it can be resolved. Once detected, broad-spectrum antimicrobial administration in combination with surgical management constitutes the hallmark of treatment for osteomyelitis (9,10). Prognosis of

osteomyelitis is dependent on immune status, severity and duration of injury, and aggressiveness of therapy (9,11). Even though antibiotics and surgery can be used to slow progression of chronic osteomyelitis, it is best to prevent chronic infection by early detection and treatment.

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